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(54) Manufacturing process for an article

(57) The present invention applies to a basic procedure comprising the use of at least one type of element in a work station (10) with the assembly of a semifinished manufacture, transfer of the semifinished manufacture to a subsequent work station (10), and repetition of the above operations in successive work stations (10) until completion of the manufacture. In accordance with the present invention in at least one of the work stations (10) and for each type of element which is to be used in the work station there are required the supply of the elements to the work station in identical containers (30) always containing the same number of elements, the provision of a single container in a work position (11) of the work station and at least one other container in a service position (21) of the work station (10) beside the work position (11), the use of the elements contained in the container placed in the work position until emptying thereof, moving the empty container into an outlet area (22) of the service position, moving a full container into the work position, taking it from an input area (23) of the service position, removal of the empty container from the outlet area of the service position and deposit within a predetermined resupply time of a corresponding full container in the input area of the same service position. The number of containers in the service position and of elements in each container and the resupply time are predetermined on the basis of elements consumption in the work station in such a manner that there is always present in the work station a preset minimum stock of elements.

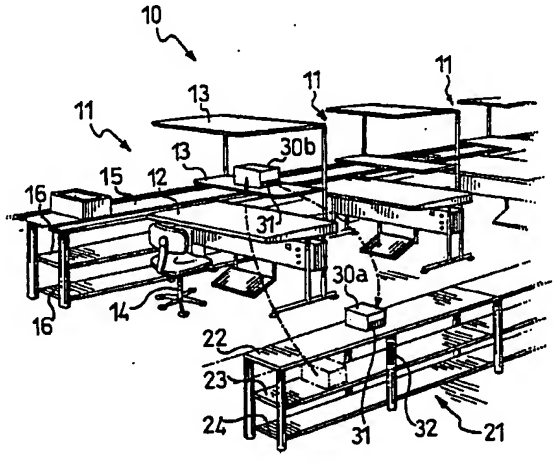

FIG.2

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Description

The present invention relates to a process for the production of a manufacture starting from a plurality of elements and a work station for the production of a manufacture in accordance with this process. By the term elements is meant here either parts designed to be assembled in the manufacture or consumable materials used in the production of the manufacture.

Processes in which the manufacture is built in successive work stations in each of which a human or mechanical operator provides for one or more operations by using a certain number of types of different elements and assembling in this manner a semifinished product which is transferred to the following station until the manufacture is completed are known and widely used. During production, there is consumption of elements in the station making necessary periodical resupply.

The overall efficiency of production of the manufacture depends among other things on how each work station is supplied with the elements to be used. Specifically it is necessary that the elements to be used are never lacking (or better, are always present in at least a predetermined quantity termed 'minimum stock') so as not to cause interruptions in production but it is preferable that there not be too many. Indeed, each element stopped in a work station costs both as locked up capital equal in value to the element concerned and as the requirement to provide space to store it; naturally, depending on the value and space occupied of the individual elements, one or the other of these costs could predominate.

The ideal condition for greatest efficiency of the individual work station would be that in which the minimum stock is zero elements and an individual element is supplied immediately to the station as soon as the preceding one has been used. However, such a process is not always acceptable because it creates a serious risk of production shutdown for a very slight delay in elements resupply.

In practice therefore a minimum stock above zero is used. Resupply takes place in lots (reorder lots) containing a predetermined number of elements, and the time (resupply time) elapsing between the moment a work station requires resupply (reorder point) and the moment the resupply takes place is more than zero. Determination of minimum stock, reorder lot, reorder point and resupply time is made case by case depending on the type of production and the elements to be used so as to optimize overall management.

A known manufacture production process which allows good production efficiency is the one designated by the Japanese term 'kanban'. In accordance with this process, the lots of elements in the work station are organized in a queue: the work station operator uses the lots starting from one end of the queue while resupply takes place at the opposite end. The reorder point is signaled visually by a moving signal placed at the beginning of a lot: reaching this 'signaled' lot means that the reorder point has been reached. After reordering, i.e. after the resupply order, the moving signal is moved forward in the queue by exactly one reorder lot. This system makes visually clear the remoteness, nearness or reaching of the reorder point. Experience has shown the effectiveness of this process in increasing production efficiency. However, management of the moving signals lends itself to errors by the work station operator (wrong repositioning after a reorder) while performing the reorders, usually done on purposeful reorder forms, is laborious and subject to errors.

The problem at the base of the present invention is to conceive a process permitting further increase in production efficiency while reducing the possibility of errors and allowing if necessary even automatic handling of the reorders and resupplies to the individual stations.

Accordingly, the present invention concerns in a first aspect a process for the production of a manufacture starting from a plurality of elements and comprising the steps of:

- use of at least one type of element in a work station with assembly of a semifinished manufacture,
- transfer of the semifinished manufacture to a following work station,
- repetition of the above operations in successive work stations until completion of the manufacture,

characterized in that it includes in at least one of the work stations and for each element type which must be used in the work station the following steps:

- supply of the elements to the work station in identical containers always containing the same number of elements,
- provision of a single container in a work position of the work station and at least one other container in a service position of the work station beside the work position,
- use of the elements contained in the container placed in the work position until emptying thereof,
- moving of the empty container to an outlet area of the service position,
- moving of a full container into the work position, taking it from an input area of the service position,
- removal of the empty container from the outlet area of the service position and deposit within a predetermined resupply time of a corresponding full container in the inlet area of the same service position,

in which the number of containers in the service position, the number of elements in each container and the resupply time are predetermined on the basis of elements consumption in the work station so that in the work station, between the work position and the service position, there is always present a preset minimum stock of elements.

By this process the reorder point is signaled by the

empty elements container placed in a predetermined area. It is accordingly not necessary to use any other signal. It is noted also that thanks to the present invention the work position must receive only one container for each of the elements used in the position, and not all the stock, with a clear advantage during the production operations. The containers beyond the first are held in the service position, in the input area if full or in the outlet area if empty.

It is noted in any case that the term 'container' as used in this text is to be understood in a broad sense either as an individual container which by itself contains all the reorder lot, or as a predetermined group of a certain number of containers which together contain the reorder lot. Indeed, it may sometimes be preferable to share the reorder lot between several containers, e.g. if it is very cumbersome.

It is also noted that the above explanation, and in particular the sameness of the number of elements contained in a container of a certain type of elements refers to a single, specific process. If the production parameters are changed, different processing is assumed and the number of elements of each type can if necessary change in accordance with the changed requirements.

Preferably the process also includes the steps of:

- marking of each container with a container tag bearing information on the type and if necessary the number of elements contained in the container when full. This marking allows associating complete information with each container. If the container is full the information will be for its contents. If the container is empty the information will be either for how it is to be filled or especially for what is to be supplied to the work station from which it arrives. In other words, each marked empty container bears with it the complete contents of a resupply order.

The container tag can be in human readable form or machine readable form or both. A machine readable form permits information acquisition automation while human readability is appropriate where there are provided even partially manual controls and operations.

Preferably the process also includes the steps of:

- marking each work station with a station tag bearing machine readable station identifying information. This marking allows reliable identification of each work station in machine understandable form and thus permits automation of the operations connected with reordering.

In particular and preferably the process can include the steps of:

- reading the container and station tags for each empty container in the outlet area of a service position,
- sending the data read to a control center,
- processing the data in the control center with execution of a resupply order for replacement of the empty containers with full containers,
- reading of the container and station tags upon each replacement of an empty container with a full one in a service position,
- sending the data read to the control center, and
- processing the data in the control center so as to verify order execution.

In this manner there is obtained nearly completely automated handling of the operations connected with the reorder with reduction of any possibility of error.

Preferably the input areas are provided in the same position in all service positions and the outlet areas are provided in the same position in all service positions. This permits keeping a more orderly situation in the service positions and especially clearer indication of the presence of an empty container in the outlet area.

Preferably every service position has an upper shelf and a lower shelf with the upper shelf being the outlet area and the lower shelf being the input area. The higher positioning of the outlet area maximizes visibility of the empty containers present in these areas.

In another aspect, the present invention concerns a work station for a manufacture production line including a work position in which is used at least one type of element for the assembly of a semifinished manufacture with the individual elements of the same type being supplied to the work station in identical containers containing the same number of elements and characterized in that it comprises a service position beside the work position with the service position comprising in turn separate input and outlet areas, in the work position there being housed for each type of elements only one of the element containers, with other containers of the same type of elements being housed in the service position in the input area if full and in the outlet area if empty.

This work station permits implementation of the process set forth above.

Preferably the service position includes an upper shelf forming the outlet area and a lower shelf forming the input area.

Preferably the work station includes a tag bearing station identifying information in machine readable and/or human readable form.

Further purposes and advantages of a process in accordance with the present invention are clarified in the detailed description of an embodiment thereof given below with reference to the annexed drawings wherein:

FIGS 1, 2 and 3 are schematic perspective views of a production line with some work positions and service positions under different working conditions.

With reference to the figures reference number 10

indicates as a whole a work station in a manufacture production line which includes a plurality of work stations. Each work station comprises a work position 11 which can have even very different forms depending on the type of production implemented on the line 10 and provides for the presence of a human or mechanical operator (not shown in the FIGS). In the FIGS there is shown by way of example a typical manual assembly production line in which each work position 11 comprises a work bench 12, one or more auxiliary support shelves 13 and a seat 14 for the human operator. Beside the work positions 11 is located a conveyor 15 for moving the semifinished manufactures from one work position 11 to the following one. In the conveyor structure 15 there can be provided additional auxiliary support shelves 16.

In each work station 10, with the work position 11 there is associated a service position 21 located beside the work position 11 on the side opposite that of the conveyor 15. Each service position 21 comprises an outlet area 22 made up of at least one first upper shelf, also indicated by 22, and an input area 23 made up of at least one second shelf also indicated by 23. The service position 21 can if necessary provide other auxiliary support shelves 24. In the example illustrated the subsequent service positions 21 are structurally connected to each other and the shelves 22, 23 and 24 of the following service positions follow one after the other.

In the FIGS there are also shown some containers 30 for elements (not shown) necessary for production. For a given production run all the containers 30 related to the same type of elements always contain the same number of elements (when full). For greater drawing clarity the situation shown in the FIGS provides that in work position 11 in the foreground there be used a single element (but there could be two or many more) and that its resupply be accomplished by means of only two containers (but there could be three or more). In addition, in FIGS 2 and 3 is also shown in broken lines the position occupied previously by a container just removed.

In FIG 1 is shown an example of a normal situation during production. A container 30a with the elements necessary for production is in work position 11 (set e.g. on one of the support shelves 13) while another container 30b containing the same type of elements is in service position 21 set on the second shelf 23 (input area). The operator (not shown) performs the operations provided for in work position 11 using the elements contained in container 30a placed on shelf 13 of work position 11 until container 30a is completely empty.

After container 30a has been emptied the operator transfers this empty container 30a from work position 11, on shelf 13, to service position 21 on the first shelf 22 (outlet area) and the full container 30b from service position 21 on the second shelf 23 (input area) to work position 11, on shelf 13. These movements are shown in FIG 2. The operator continues processing using the elements in container 30b.

At the same time container 30a placed in outlet area 22 of service position 21 constitutes by its presence a resupply order for a full container. The resupply order is taken by a service operator (different from the operator of work station 10 and likewise not shown) who attends to securing another full container 30 to replace the empty container 30a.

At the end of the necessary time (resupply time) the service operator places a full container 30c in input area 23 and removes empty container 30a from outlet area 22 of service position 21. These operations are illustrated in FIG 3. Thus the normal situation shown in FIG 1 is restored with the container 30c in place of container 30b in input area 23 of service position 21 and with container 30b in place of container 30a on shelf 13 of work position 11.

Preferably each container 30 is marked with a tag 31 bearing information on the type and if necessary number of elements contained in container 30 when full. The information on tag 31 is presented in a form readable by a human operator or in a form readable by a machine, e.g. by means of an optical code (bar code, two-dimensional code, color code or the like). Quantity information can be left out if it is expected to change production parameters often so as to require frequent changes in the quantity of elements in the containers. In this case quantity information for each type of element and each station can be memorized centrally.

Similarly, each work station 10 is marked with a tag 32 placed e.g. on service position 21 and containing identifying information on work station 10. Information on tag 32 is presented in a form readable by a human operator or in a form readable by a machine, e.g. by means of an optical code (bar code, two-dimensional code, color code or the like).

These tags 31 and 32 permit the service operator to read the resupply order rapidly using a portable code reader, memorizing the information on container 30 which is the object of the resupply order and on work station 10 which requires it. The information memorized can then be fed into a control center (not shown) connected to a storeroom (or a supplier) to allow preparation of the full container 30 for resupply.

As an alternative each service position could be equipped with fixed equipment for reading tags 31 on containers 30 and connected in a network with control center so as to send resupply orders directly upon movement of containers 30 into the service position.

Claims

1. Process for the production of a manufacture starting from a plurality of elements and comprising the steps of:

   - use of at least one type of element in a work station with assembly of a semifinished manu-

facture,

- transfer of the semifinished manufacture to a following work station,
- repetition of the above operations in successive work stations until completion of the manufacture, and characterized in that it includes in at least one of the work stations and for each element type which must be used in the work station the following steps:
- supply of the elements to the work station in identical containers always containing the same number of elements,
- provision of a single container in a work position of the work station and at least one other container in a service position of the work station beside the work position,
- use of the elements contained in the container placed in the work position until emptying thereof,
- moving of the empty container to an outlet area of the service position,
- moving of a full container into the work position, taking it from an input area of the service position, and
- removal of the empty container from the outlet area of the service position and deposit within a predetermined resupply time of a corresponding full container in the inlet area of the same service position, and in which the number of containers in the service position, the number of elements in each container and the resupply time are predetermined on the basis of elements consumption in the work station so that in the work station, between the work position and the service position, there is always present a preset minimum stock of elements.

2. Process in accordance with claim 1 and comprising the steps of:

   - marking of each container with a container tag bearing information on the type of elements contained in said container when full.

3. Process in accordance with claim 2 in which the container tag bears information on the quantity of elements contained in said container when full.

4. Process in accordance with claims 2 or 3 in which the container tag is in human readable form.

5. Process in accordance with claim 2 or 3 in which the container tag is in machine readable form.

6. Process in accordance with claim 2 or 3 in which the container tag is in human readable form and in machine readable form.

7. Process in accordance with claim 5 or 6 and including the steps of:

   - marking each work station with a station tag bearing machine readable station identifying information.

8. Process in accordance with claim 7 and comprising the steps of:

   - reading the container and station tags for each empty container in the outlet area of a service position,
   - sending the data read to a control center,
   - processing the data in the control center with execution of a resupply order for replacement of the empty containers with full containers,
   - reading of the container and station tags upon each replacement of an empty container with a full one in a service position,
   - sending the data read to the control center, and
   - processing the data in the control center so as to verify order execution.

9. Process in accordance with any of the above claims in which the input areas are located in the same position in all the service positions and the outlet areas are located in the same position in all the service positions.

10. Process in accordance with claim 9 in which each service position comprises an upper shelf and a lower shelf with the upper shelf constituting the outlet area and the lower shelf constituting the input area.

11. Manufacture production line work station comprising a work position in which is used at least one type of element for assembly of a semifinished manufacture with the individual elements of the same type being supplied to the work station in identical containers containing the same quantity of elements, characterized in that it comprises a service position beside the work position with the service position comprising in turn separate input and outlet areas, in the work position there being located for each type of elements only one of the element containers, with other containers of the same type of elements being located in the service position in the input area if full and in the outlet area if empty.

12. Work station in accordance with claim 11 in which the service position comprises an upper shelf forming the outlet area and a lower shelf forming the input area.

13. Work station in accordance with claim 11 compris-

ing a tag bearing station identifying information in machine readable and/or human readable form.

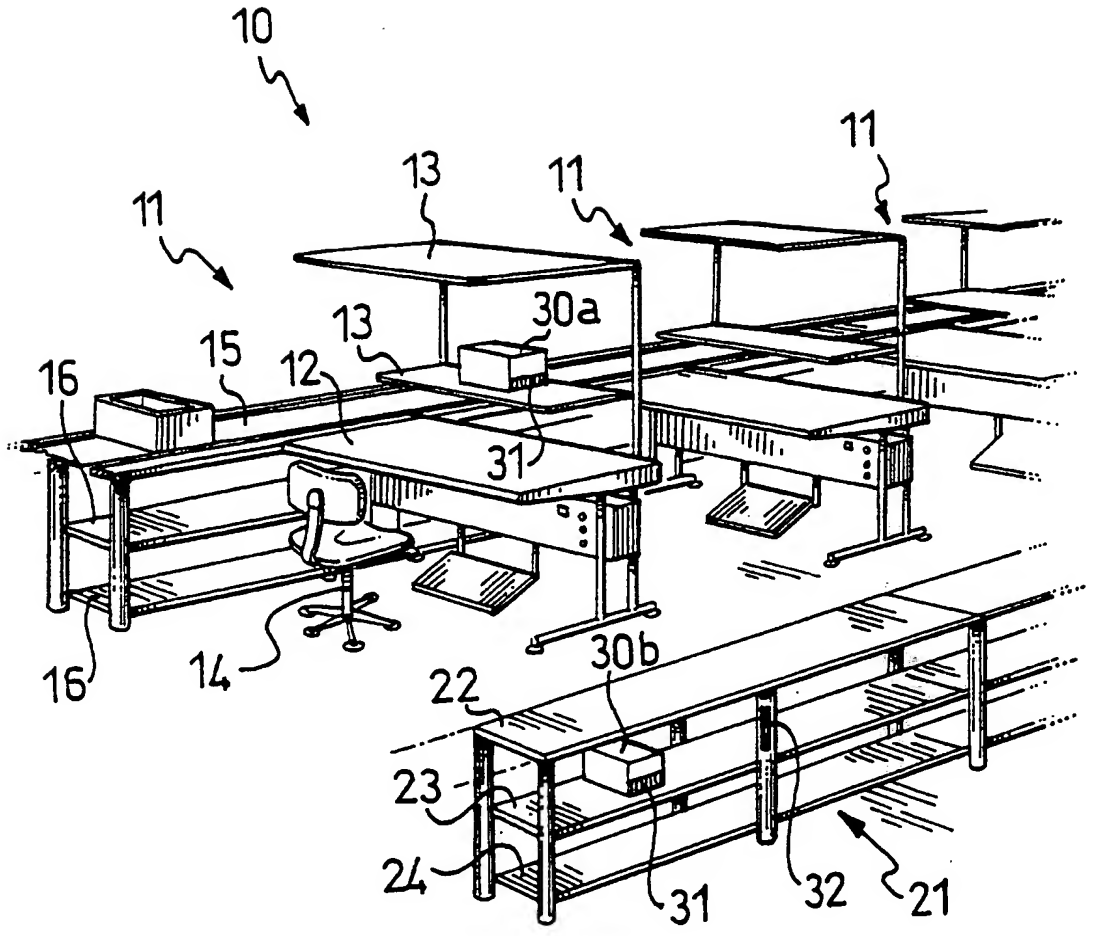

FIG.1

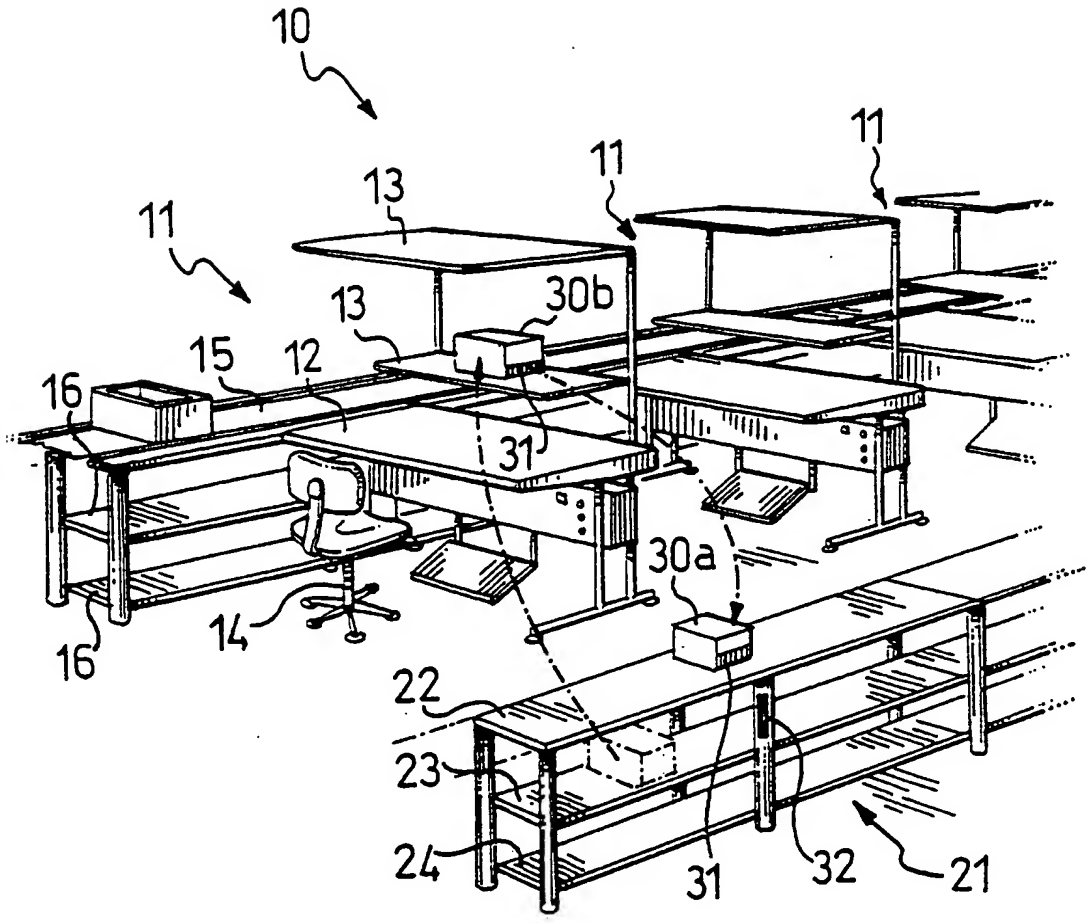

FIG.2

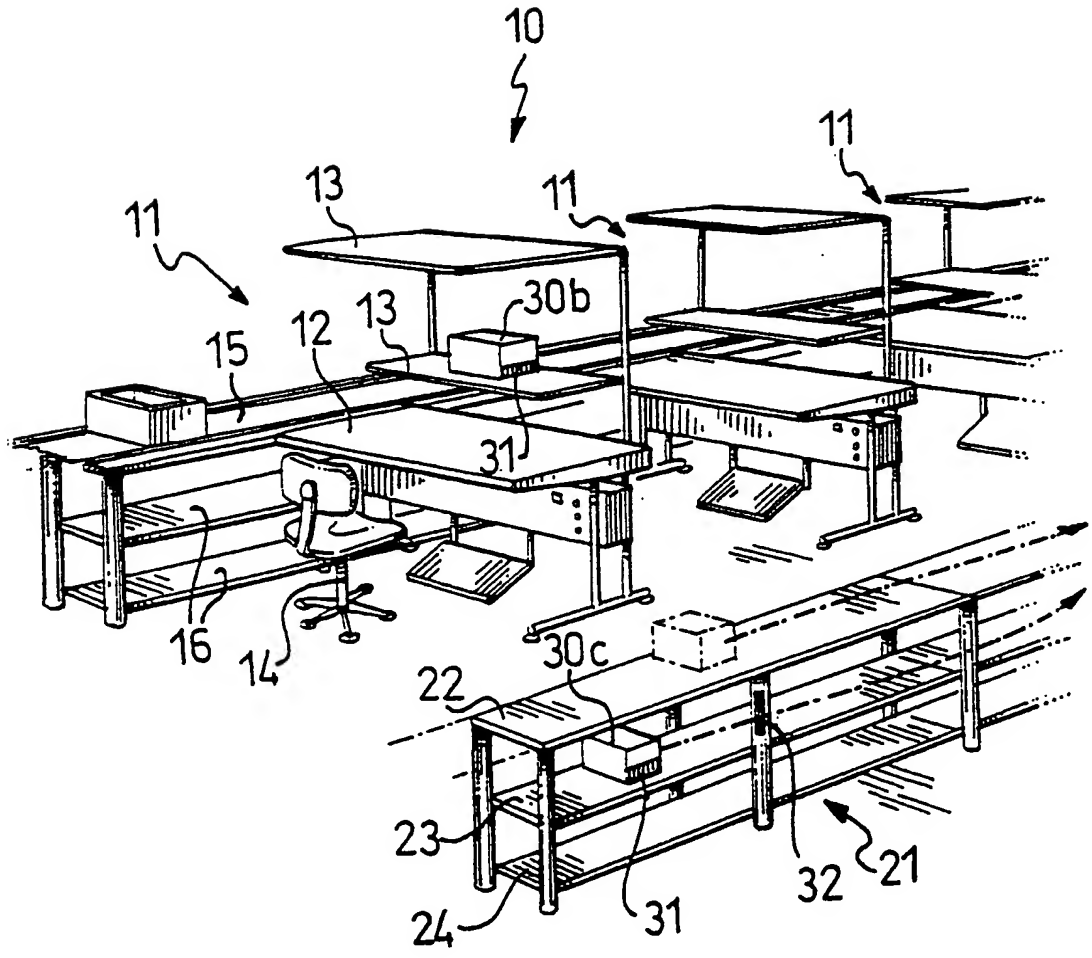

FIG.3

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EUROPEAN SEARCH REPORT

Application Number
EP 96 83 0651

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.6)
X A	US 4 669 047 A (CHUCTA) * abstract; figures * * column 4, line 64 - column 5, line 19 * * column 6, line 51 - column 7, line 3 *	1-6,9-12 7,8,13	B23P19/00 B23P21/00 G05B19/418 B23Q7/10
X A	EP 0 606 515 A (PFU LIMITED) * column 5, line 4 - column 7, line 16; figure 2 *	11,12 1,13	
A	PATENT ABSTRACTS OF JAPAN vol. 10, no. 304 (M-526), 16 October 1986 & JP 61 117033 A (HITACHI), 4 June 1986, * abstract *	1,11	
A	PATENT ABSTRACTS OF JAPAN vol. 12, no. 257 (M-719), 20 July 1988 & JP 63 039746 A (TOYOTA), 20 February 1988, * abstract *	1	
A	PATENT ABSTRACTS OF JAPAN vol. 96, no. 11, 29 November 1996 & JP 08 169511 A (FUJI), 2 July 1996, * abstract *	1	TECHNICAL FIELDS SEARCHED (Int.Cl.6) B23P G05B B23Q B65G
A	IBM TECHNICAL DISLOSURE BULLETIN, vol. 31, no. 7, December 1988, ARMONK,NY,USA, pages 78-79, XP000035724 "Standardized design for automated work cell" * the whole document *	1,11	
A	US 4 787 141 A (MIYAZAKI ET AL) * figure 1 *	11,12	

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The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	30 May 1997	Plastiras, D

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
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A : technological background
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EUROPEAN SEARCH REPORT

Application Number
EP 96 83 0651

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.6)
A	MANUFACTURING REVIEW, vol. 4, no. 1, March 1991, NY,USA, pages 44-52, XP000204977 Y. SEO ET AL: "Configuration and operation of a pull-type manufacturing system"		

TECHNICAL FIELDS SEARCHED (Int.Cl.6)

The present search report has been drawn up for all claims

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